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Request for grant of a patent

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1. Your reference

C1192/A

2. Patent application number
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0415202.1

07 JUL 2004

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

AEW Delford Group Ltd
Main Road
Harwich
CO12 4LP

Patents ADP number *(if you know it)*

8729220001

If the applicant is a corporate body, give the country/state of its incorporation

England

4. Title of the invention

Improved pick and place gripper

5. Name of your agent *(if you have one)*

Keith W Nash & Co

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

90-92 Regent Street
Cambridge
CB2 1DP

Patents ADP number *(if you know it)*

1206001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

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a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
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Yes a)

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Claim*(s)*	0
Abstract	0
Drawing*(s)*	7 + 7 //

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Translations of priority documents

Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*

Request for preliminary examination and search *(Patents Form 9/77)*

Request for substantive examination *(Patents Form 10/77)*

Any other documents *(please specify)*

11. I/We request the grant of a patent on the basis of this application.

Signature ~~~ Date 6/7/04

Keith W Nash & Co, Agents

12. Name and daytime telephone number of person to contact in the United Kingdom

Mr Nash (01223) 355477

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Patents Form 1/77

Patents Form 1/77
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28 OCT 2003
NEWPORT

The Patent Office

28OCT03 E847703-1 D02819
P01/7700 0.00-0325068.5

The Patent Office

Cardiff Road
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South Wales
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Request for grant of a patent

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1. Your reference — C1156/A

2. Patent application number *(The Patent Office will fill in this part)* — 28 OCT 2003 — 0325068.5

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

AEW Delford Group Ltd
Main Road
Harwich
CO12 4LP

08789992001

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation — England

4. Title of the invention — Improved pick and place gripper

5. Name of your agent *(if you have one)* — Keith W Nash & Co

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

90-92 Regent Street
Cambridge
CB2 1DP

Patents ADP number *(if you know it)* — 1206001

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Number of earlier application	Date of filing *(day / month / year)*

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Abstract	
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Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature Date 27/10/2003

Keith W Nash & Co., Agents

12. Name and daytime telephone number of person to contact in the United Kingdom — Keith Nash 01223 355477

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C1156/A

Title: Improved pick and place gripper

Field of invention

This invention concerns gripping devices (tooling) by which articles, especially but not exclusively portions of foodstuff, can be picked up from one place (typically a conveyor belt) moved and located at another place (typically onto another conveyor or into a container such as a tray on another conveyor).

Background

In the food processing and packaging industry it is known to cut large pieces of foodstuff such as meat, into smaller, usually similarly sized, portions and then to pack the cut portions individually or more commonly in groups of two, three or more, for display (usually in chilled or frozen display cabinets) for selection by the public for purchase.

Thus pork and lamb are cut into chops, beef into steaks and bacon into thin slices. The cutting from the bulk product is often achieved using a rotating blade and the portions (i.e. chops or steaks) are allowed to fall one after another onto a moving conveyor belt.

An escapement mechanism may be provided so that the portions are separated along the length of the conveyor, and in general the portions will tend to fall in a similar way so that for example in the case of port chops the edge of each chop which is covered by a layer of fat may for example always be the leading (or trailing) edge of each chop in the line – depending on whether the bulk pork from which they are cut is fat side up or fat side down.

However there is no guarantee that the portions will be so aligned on the conveyor.

It is considered desirable for the portions (e.g. chops) which are to be presented in a so-called pre-pack, to all be aligned in a similar manner and either shingled (so that except for the topmost portion, those below are partly obscured by those above), or the portions are attractively arranged side by side on a flat tray, so that the size and quality of all of the portions making up the pack can be seen.

Hitherto the picking up and placing of portions into trays or other containers, has been at least in part performed manually. While this has meant that product orientation has not been called for on the conveyor, the process is labour intensive, and production limited to the speed at which the operators can pick and place the portions. The work is also tedious.

It is an object of the present invention to automate the above process.

It is another object to provide apparatus which can be employed in use to pick and place similar articles (which may be similar items of food but could be any similarly sized articles such as small manufactured items), which are to be packed for storage, and display for selling.

Existing technology

Computer controlled robots have been developed and are available from ABB Ltd of Milton Keynes, England.

The IRB 340 and IRB 340SA robotic arms are especially suited to picking up foodstuff items such as pork or lamb chops, steaks, chicken portions, fish fillets and the like, elevating each picked up article so as to allow it to be moved laterally to another position (such as onto a parallel conveyor) where it can be lowered or dropped onto the other conveyor or onto a tray on the other conveyor.

During lifting, moving and lowering, the robot is adapted to be capable of rotating the article it has picked up, through up to 360° although for most purposes up to 180° of rotation in either direction from the position when it first engages the article, is sufficient.

To facilitate the positioning of the robot, video cameras, positioning sensors direction of movement and speed of movement transducers linked to each conveyor are provided to supply information to the controlling computer. In this way the arrival of the next article to be picked up by the robot can be flagged, its precise position across the width of the conveyor can be supplied to the computer, and if it is shaped (in plan view) or marked, so that its orientation can be visually determined, cameras viewing the articles can supply information which enables the computer to determine the precise orientation of each article and therefore determine by how much it needs to be rotated, so as to occupy a given orientation when positioned on the second conveyor (or in a tray thereon).

Where articles are stacked or shingled they can be picked and placed as one.

It is an object of the present invention to provide a tool (gripper) which can be mounted to and operated by such a robotic arm.

Summary of the invention

According to the present invention tooling is provided which is adapted to be secured to the movable end of a computer controlled robotic arm by which in use articles can be picked up from one position, optionally rotated in transit and lowered into a second position, which tooling comprises

(a) two blades each having a leading edge and trailing edge, and both being movable between a first position in which their leading edges are separated by a large gap and a second position in which the leading edges are in contact or are separated by a smaller gap, and

(b) drive means for effecting relative movement between the two blades for moving them between the first and second positions,

whereby in use with the blades in the first position the tooling can be lowered so that the undersides of the two blades just make contact with a surface on which an article is resting with the two leading edges of the blades on opposite sides of the article and the latter can be picked up by the blades by operating the drive means so as to move the blades into their second position below the article.

Preferably the thickness of the blades is selected so that there is little tendency for the leading edge of either blade to push the article ahead of the blade as the leading edges engage the article, but rather to slide between the article and the surface on which the article is located.

Preferably the leading edge of each blade is bevelled or rounded so as not to present a cutting edge to the article.

Preferably the drive means acts to move the two blades at high speed between the two positions, so that there is little tendency for friction between the surface of the blades and the underside of the article to cause the latter to move laterally with either of the blades.

Preferably the blades are similar in size and shape and thickness and are made from similar material and have a similar surface finish at least on their upper faces which make sliding contact with the underside of the article as they move into their second position.

Preferably the surface finish of the undersides of the blades is also similar.

Preferably the speed of movement of each blade is similar to that of the other, albeit in a generally opposite sense.

Preferably the size and shape of the blades is selected so that the area of each blade available to slide below the article is greater than 50% of the area of the article.

Preferably the trailing edge of each blades includes an upstanding lip or ridge or wall which may engage opposite edge regions of the article when the blades occupy their second position.

Each lip, ridge or wall may be integral with the blade (as by bending up or moulding or otherwise forming the trailing edge of the blade to form a lip) or may comprise a separate member which is secured to the upper face of the blade adjacent to its trailing edge,.as for example by adhesive, or welding, or rivets, or screws, and preferably spaced from the blade to facilitate cleaning.

In order to prevent unwanted rotational skewing or twisting or lateral movement of any kind, of an article relative to the blades, as the latter slide therebelow, the tooling preferably includes an article engaging device which in use is adapted to engage an upper face of an article over which the tooling is lowered, and is further adapted to remain stationary while the blades move relatively thereto whereby the engagement between the device and the article will resist lateral movement of the latter as a result of movement of the blades relative thereto.

In one arrangement the movement restraining device comprises one or more spikes which point generally perpendicularly downwardly towards the plane containing the two blades, with the or each pointed end spaced from the said plane by a distance which is less than the thickness of each article to be picked up by the tooling, so that as the tooling is lowered onto an article the spikes penetrate the article before the blades make contact with a surface on which the article rests, such as a conveyor.

In order to prevent an article remaining impaled on the spike or spikes, after the blades are opened to release the article, the movement restraining device may further comprise ejector means which acts to push the article off the spike or spikes, as the blades move

towards their second (open) position. The ejector means may be operated by the blade drive means (or by a linkage which is operated in response to movement of at least one of the blades).

Typically the ejector means comprises at least one pin which is withdrawn upwardly as the blades move into their first (closed) position but is moved downwardly into a protruding position as the blades move into their second (open) position, so as to push the article in a similar downward direction, off the spike or spikes.

In another arrangement the movement restraining device comprises at least one resiliently deformable member located above the plane containing the two blades, and spaced therefrom by a distance which is less than the thickness of each article to be picked up by the tooling, so that as the tooling is lowered onto an article, the underside of the deformable means engages the upper surface of the article and the member becomes deformed in order to accommodate the thickness of the article, the resulting downward force on the article, and frictional resistance to movement between the deformable means and the article, serving to restrain the latter from moving under the influence of blade movement therebelow.

The deformable means may comprise a block of resiliently deformable materia, a sprung plate or block, or a dished plate of spring steel or the like, or one or more fingers of spring steel or the like, having lateral stiffness but being adapted to deflect resiliently in an upward direction, relative to the blades.

Typically the or each finger is of spring steel and is bent so as to point downwardly to engage the upper surface of the article, but which can be more or less flattened by an upward force, so as to accommodate the thickness of the article. The fingers may include two or more further bends to increase the area of the finger in contact with the article.

Alternatively the tooling may include a vacuum chuck which is adapted to become vacuum clamped to the upper surface of the article as the tooling moves downwardly onto the

article, and is adapted to release the article therefrom possible using a positive pressure air pulse, as the blades are opened, to deposit the article at its second position.

Rotation of the article in transit between the first and second positions may be achieved by rotating one part of the robotic arm relative to another part thereof, or rotating the tooling relative to the robotic arm, or where the rotation restraining means comprises two or more spikes which positively engage in the article, rotating a member from which the spikes depend in a plane which is parallel to the plane containing the two blades, so that the article is rotated relative to the blades.

Where the robotic arm itself is not torsionally stiff, or the connection between the arm and the tooling, or the arm and a fixed support, allows relative rotational movement to occur due to wear, inherent lost motion or lack of torsional stiffness in the or each connection, any force exerted on the blades during pick-up or any reaction torque transmitted to the arm as the blades are opened, may cause the tooling to rotate through a small angle at a crucial point in the pick and place cycle.

This is especially of concern when the blades are opening to release the article, since backlash in the arm and connections and/or inherent flexibility in the torsional axis of the robotic arm, can result in the article being incorrectly orientated by the arm and tooling when it is released, if the opening of the blades generates a reaction torque on the torsion drive axis of the robotic arm.

Therefore according to a particularly preferred feature of the invention, the mechanism by which the two blades are caused to move is selected so as to exert negligible (preferably zero) torque about the torsion drive axis of the robotic arm and/or about the rotational axis between the arm and the tooling and/or about any axis about which one part of the arm can rotate relative to another part thereof.

Preferably the tooling includes a bridge which is adapted to be attached centrally to the robotic arm, to which the two blades are pivotally mounted at opposite ends, and to which

is also connected the drive means by which the blades are moved between their first and second positions.

Preferably the bridge is of aluminium or plastics as are any struts or mountings for attaching the blades to the bridge or drive, so as to keep the weight of the tooling to the minimum.

Each plate may be made from plastics but is preferably made from stainless steel, and typically is of the order of 0.5mm thick.

Preferably an elongate Nylon® block is secured along but spaced from the trailing edge of each blade.

The drive means may be such as acts equally and oppositely on the two blades or may be such as to act on one of the blades with a connection between the two blades to transmit drive to the other blade, so as to cause it to move in an appropriate manner relative to the driven blade.

The drive means may be double acting in the sense that it exerts a positive driving force on the or each blade, in both directions of blade movement.

Alternatively the drive means may act only to move the blades in one sense, and spring means acts to move them back in the opposite sense once the drive means is de-energised or disengaged.

Where the robotic arm includes a rotational drive, for rotating tooling attached thereto relative to the arm, this may be employed for orientating the tooling and therefore an article therein, during transit.

Alternatively the robotic arm rotational drive may be employed to mechanically actuate drive means on the tooling for effecting relative movement of the blades.

Where the tooling includes a bridge as aforesaid and the blades are pivotable relative to the bridge, the drive means may be attached in part to the bridge to move the blades relative to the bridge and thereby relative to one another.

Where the blades are to be pressed into contact with a flat surface, such as the upper surface of a smooth conveyor belt on which articles are carried, just prior to their inward sliding movement below one of the articles, a resilient lost motion connection may be provided between the blades and the robotic arm. This permits the blades to make contact with the article supporting surface shortly before the downward movement of the end of the robotic arm carrying the tooling is stopped, and for the final movement of the robotic arm to compress the resilient lost motion connection after the blades make contact with the said surface. The energy stored in the compression of the resilient lost motion connection exerts a downward force on the blades (which is resisted by the said surface, e.g. the conveyor) which ensures that the blades remain in sliding contact with the surface and do not lift as they move towards and engage the article, but instead continue to push under the article and lift it, to enable the blades to close.

The lost motion connection may be between the robotic arm and the tooling or where the tooling includes a rigid bridge, may be between the blades and the bridge.

Where the blade drive means is attached in part to the bridge, preferably a lost motion connection is provided between the drive means and the bridge or between the drive means and the blade (or blades), to accommodate any lost motion between the bridge and the blades. Alternatively the drive means may be torsionally stiff in a plane parallel to that in which the blades move but capable of flexing or distorting or rising and falling as by pivoting in a plane which is perpendicular to the plane in which the blades move, so as to accommodate the lost motion between the blades and the bridge.

The drive means for moving the blades may be electrically powered, and may comprise a solenoid or rotational electromagnetic drive, but is preferably pneumatically powered and

comprises a pneumatically extensible strut, preferably a double acting strut and movement of the piston in the cylinder of the strut is achieved by applying positive pressure to one end or the other of the cylinder, as required.

Air under pressure is preferably supplied to a valve carried by the arm or the tooling, preferably on a bridge of the latter, and the valve is either solenoid operated to direct the air pressure to one end or the other of the strut, or is pneumatically operated by second air-line means from the, or another source of air under pressure, under the control of a computer which may be that which controls the robotic arm.

The blades may rotate relative to one another and/or to a bridge forming part of the tooling, or may slide linearly relative to each other or to the bridge.

Where the blades are carried below a bridge, the gap between the bridge and the blades may be adjustable to allow different heights of article to be accommodated within the tooling.

The invention is not limited to picking up single articles, and by appropriately dimensioning the blades and their travel and the gap between the blades and any supporting bridge, a stack of two or more articles arranged one above the other (such as a stack of bacon slices) may be picked up by the tooling.

Likewise if two or more portions of meat such as chops or steaks or fish fillets have been arranged into a shingled array on the conveyor, tooling constructed and operated in accordance with the invention may be employed to pick and place the shingled array, without disturbing the relationship of portions making up the array.

Preferably the tooling is orientated relative to a shingled array so that the two blades advance towards the array along a line which is generally orthogonal to the direction in which the portions are shingled.

Preferably therefore the tooling is constructed with a viewing system which provides image signals to the robotic arm controlling computer, which enables the latter to determine the orientation of each article and in particular the shingling direction of a shingled array, and to generate control signals for rotating the tooling accordingly to ensure that before the tooling engages an article, such as a shingled array, its orientation relative to the article or array is such that the blades will move appropriately relative to the article or array.

Accordingly any reference to article herein can mean a single item or a stack or shingled array of two or more such items.

The invention also lies in a product handling system comprising a first conveyor, a second conveyor spaced from the first, a robotic arm and computer control therefor, having tooling attached to its remote and movable end constructed as aforesaid, both arm and tooling being controllable by signals from the computer to position the tooling around an article on one conveyor and slide the blades thereof below the article, and thereafter lift the article from the one conveyor by appropriately controlling the robotic arm, and moving the arm and therefore the article containing tooling so as to position it over the other conveyor and by appropriate control signals from the computer, to open the blades and deposit the article on the other conveyor.

The arm may be moved under computer control in a downward sense after the tooling has been positioned over the said other conveyor before the blades are opened, thereby to control the distance through which the article has to drop onto the other conveyor on being released.

The system may include cameras and sensors which produce signals by which the computer can determine the position and/or orientation and/or nature of each article on the said one conveyor, and can generate control signals to cause drives to operate to lift and/or rotate and/or lower the tooling and/or adjust the robotic arm so that the tooling is positioned at just the right time relative to an article travelling on the one conveyor to

enable the tooling to pick it up therefrom and if required to rotate it in transit and position it on the other conveyor at precisely the right point in time and in the correct orientation.

The said other conveyor may have trays or other containers thereon, and the viewing system and sensors may be set up so as to identify the precise position of each tray or container relative to the robotic arm, and the computer may be programmed to control the movement of the said other conveyor as well as the said one conveyor, to ensure that a specific tray or container is at a specific position at a specific time to allow a specific article picked from the one conveyor to be placed in the said tray or container by tooling operating and constructed as aforesaid and carried by the robotic arm.

The invention will now be described by way of example with reference to the accompanying drawings in which:-

Fig 1 is a perspective view of an ABB Ltd IRB 340 robotic arm to the lower end of which tooling embodying the invention is to be fitted,

Fig 2 is a perspective view of tooling constructed as one embodiment of the invention, in which the two blades are shown separated so that the tooling can be lowered over an article to be picked up and moved to a second location,

Fig 3 is a similar view to that of Fig 2 but in which the two blades have been moved together,

Fig 4 is a similar view to that of Fig 3 of a modified tooling in which the upper surface of an article to be picked up is engaged by an array of sprung fingers instead of the spikes of Figs 2 and 3,

Fig 5 shows diagrammatically how the two blades are moved synchronously, and shows how a resultant toque will be experienced about the axis of the connection between the tooling and the robotic arm of Fig 1,

Fig 6-10 show different arrangements of the tooling in which the movement of the blades is such as to generate less or negligible torque on the robotic arm connection,

Fig 11 shows the tooling lowered into contact with a conveyor with the blades open but just about to move inwardly and below a pork chop,

Fig 12 shows the tooling after the blades have been moved below the chop, ready to be lifted and moved laterally by the robotic arm and dropped into a tray on an adjoining conveyor, and

Fig 13 illustrates a shingled group of chops on the one conveyor and shows the direction from which the two blades must travel to engage the shingled group to allow them to be picked up as a single article.

<u>In the drawings</u>:

Fig 1 is a perspective view of a robotic arm comprising an upper drive unit 10, three articulating arms 12, 14, 16 converging to a mounting device 18. The unit 10 is adapted to be secured to a framework typically to locate the arm over a conveyor (not shown in Fig 1).

Figs 2 and 3 show tooling which can be secured to the mounting device 18 using a central clamping collar 20. The latter is situated midway of an upper section 22 of a bridge, the main part of which 24 extends parallel and below the upper section, to protrude beyond its ends and provide two pivot mountings 26, 28 in which two pins (not visible) are rotatably and slidingly received. The main part of each pin is hidden from view but an enlarged head can be seen at 30 and 32 and the lower end of each pin protrudes below 26 and 28 respectively and is surrounded by a compression spring 34, 36.

Trapped between each head 30, 32 and the upper end of each mounting 26, 28 is an arm, shown at 38 and 40 respectively, which extends laterally from two struts 42, 44, which have similar laterally extending parallel arms 46, 48.

The arms 38 and 46 and 40, 48 have aligned bores through which the two pins pass, trapping the springs 34, 36 between the lower ends of the mountings 26, 28 and the lower arms 46, 48. Although not shown the pins protrude through the arms 46, 48 and are keyed to the two curved supports 50, 52 for two blades 54, 56.

The upper arms 38, 40 are also keyed to the pins, so that pivoting of 38 and 40 about the pin axes causes lateral movement of the blades 54, 56 towards or away from each other.

The arms 38, 40 are joined by a link 58, pivotally joined at opposite ends to the arms 38, 40 so that pivotal movement of one arm is transmitted faithfully to the other.

Drive is provided by a pneumatic cylinder 60 and piston rod 62. In Fig 2 the piston is shown fully retracted. The remote ends of the cylinder and piston are pivotally joined to a block 64 secured to the main part of the bridge 24 and to the arm 38 respectively.

In this way extending the piston rod by supplying air to the rear of the piston, the arm 38 is pivoted relative to the bridge 24, and the arm 40 is rotated through the same angle by the link 58. The end of the piston rod 62 is shown fitted to a block 66 which is pivotally joined by a pin 68 to the outboard end of arm 38 – beyond the point at which the link 58 is pivotally secured thereto.

As with the piston and cylinder, the link terminates in two blocks 70, 72 which are held captive by and are pivotable about pins 74, 76.

Centrally of the bridge member 24 is a rod 78 which at its upper end is secured to 24 and at its lower end is secured to a star shaped plate 80 having spikes such as 82 secured to the star fingers to protrude downwardly towards the plane containing the two plates 54, 56.

The spikes are adapted to engage in an article which is to be lifted by the blades, as the assembly is lowered around the article, with the blades in their open position (as shown in Fig 1). If the plate 80 is non-rotatable relative to the bridge member 24, the action of impaling the article (not shown) on the spikes reduces any tendency for the article to be pushed or rotated by the leading edges of the blades as they close from the position shown in Fig 1 to that shown in Fig 2, and in so doing to slide below the article to capture it thereon.

The blades 54, 56 are shown secured to the arms 50, 52 by means of bolts and nuts (one of the latter being designated 84) and spacers (one of which is designated by reference numeral 86), are sandwiched between the arms 50, 52 and the blades 54, 56, each bolt extending through a spacer.

The heads of the bolts (not shown) are secured to the blades so as not to protrude below the underside surface of the blades, for example by welding or brazing, and the thickness of each bolt head is conveniently accommodated within an indent (not shown) in the underside of each spacer.

Since the plates do not extend to below the ends of the arms joined to the pins held captive in the mounts 42, 44 an enlargement equal in thickness to that of each of the spacers 86 plus the blade 54 (or 56) is located below the inboard end of each arm 50, 52. It may for example be an enlarged head at the lower end of each of the pins.

The springs 34, 36 allow the arms 50, 52 and the supporting parts 42, 44 and link 58 to rise relative to the bridge members 22, 24.

The lost motion allows the blades to be pushed down into contact with the surface of a conveyor, if required, whereby the springs are compressed to accommodate the relative movement of the parts.

As soon as the assembly is once again lifted clear of the conveyor, the springs will extend so as to force arms 38, 40 into contact with the upper ends of the mounts 26, 28.

Fig 4 which shows tooling similar to that of Figs 2 and 3, but from the other side, shows an alternative to the star plate 80 and spikes 82 of Figs 2 and 3. Here the plate 80 is replaced by a spring steel plate 88 which is cut away on either side of a central section 89 to define six spring fingers, three on each side, one of which is denoted by reference numeral 90. Each of the fingers is bent as at 92, so as to extend downwardly from the central section 89, and at 94 and 96 to form article engaging pads 98.

The frictional force between the undersides of the pads 98 and an article (not shown) serves the same purpose as the engagement of the spikes 92 in an article (in relation to Figs 2 and 3) but without damaging the article.

Fig 5 shows the principle behind the geometry of the arrangement shown in Figs 2-4. Thus the plates are denoted by 54, 56 and the link by 58. The arms 38 and 40 are denoted diagrammatically. The central axis of the collar 20 is marked at 100 and the direction of rotation of the blades is denoted by arrows 102, 104.

Since both blades rotate in the same sense about 100 (whether opening or closing) there will be a resultant torque about axis 100. If the robotic arm and/or the connection between the arm and the bridge assembly 22, 24 contains any lost motion (which will appear as overrun or backlash), this torque will result in unpredictable rotational movement of the assembly and especially the blades 54, 56 relative to their expected orientation. This may result in the article being incorrectly positioned by the tooling when deposited at its new location.

To this end Figs 6-10 illustrate diagrammatically alternative drive mechanisms by which the blades move in an opposite sense as they open and/or close, so as not to create any twisting torque about 100.

In each of Figs 6-10 the axis 100 is shown as are the two blades 54, 56.

In Fig 6 two meshing toothed wheels 106, 108 are keyed to the blades 54, 56 respectively and a piston and cylinder 109 acts on arms 110, 112 to open or close the blades. Zero torque results about 100.

In Fig 7 the blades 54, 56 are carried by parallel slides 114, 116 and relative sliding movement is effected by extending a cylinder and piston 117 acting for example between the bridge (not shown) and one of the slides 116. A pinion 118 is freely rotatable about the axis 100, and the teeth of the pinion engage in teeth formed in parallel spaced apart edges of the slides 114, 115. As slide 116 is moved to the right, slide 114 is moved to the left due to the rotation of the pinion 118. Zero torque results about 100.

In Fig 8 a scissors mechanism 120 joins the two blades 54, 56 and a cylinder and piston 121 acts between two of the four outer ends 122, 124 of the mechanism. The other two outer ends 126, 128 are pivotable relative to the blades 54, 56. One of the intermediate joints 130 is slidable in a slot 132 in a fixed member 134.

Relative sliding between joints 122 and 128 and the assembly is provided by slots 136, 138 in supporting arms to allow the blades to move together (as shown in Fig 8A) and apart (as shown in Fig 8B.

Zero torque is imposed on the second intermediate joint. To this end the axis 100 is arranged to coincide with this joint which remains stationary as the other five joints of the scissors mechanism move.

Fig 9 shows an arrangement similar to that of Fig 5 except that a mounting block 136 can pivot about 138 and a link 140 (pivotally attached to the link 58) also rotates about 138 – which can also equate to axis 100 in Fig 5.

There is a reduction in torque about 138 as the blades are no longer rotated. The block 136 and links and cylinder are rotated instead.

In Fig 10 parallel links 142, 144 and 146, 148 are pivotally jointed at their ends to the blades 54, 56 and to the centre and a radially offset point of each of two meshing toothed pinions 150, 152. The central and offset points are denoted by 154, 156 and 158, 160 respectively.

The pinions are rotated by extending or retracting a cylinder and piston 161, which can be pivotally joined to the two pinions at 162, 164, or the piston is pivotally attached at 164 to a fixed part of the assembly such as a bridge member such as 22, 24 of Figs 2-4.

As the pinions counter rotate, the blades are moved together or apart, without any resultant torque.

Axis 166 is defined by the apex of a triangular support member 168 which in turn carries pins defining the rotational axes of 154 and 158, which are therefore fixed in position relative to each other, and to axis 166.

Figs 11 and 12 show tooling generally designated 170 such as illustrated in Figs 2 and 3 mounted at the lower end of a robotic arm generally designated 172 of the type illustrated in Fig 1.

In addition the arm and tooling are shown located above two conveyors 174, 176 whose directions of movement are denoted by arrows 178, 180.

Pork chops are shown at 182, 184 on conveyor 174. These are spaced apart along the conveyor and may be oriented similarly or differently depending on how they are deposited on the conveyor from processing apparatus (not shown) - typically a high-speed cutting machine set to cut chops from a large piece of meat and cause them to drop in turn onto the conveyor.

One of a number of cameras is shown at 186. This is supplied with the robotic arm 172 and a computer based control system 188 having plural inputs 190 and plural outputs 192, controls the operation of the or each of two conveyors, the arm and possibly also an escapement mechanism (not shown) for spacing the chops along conveyor 174.

In use the arm is lowered with its blades 54, 56 is their fully open position under the control of the control system 188 at the precise moment that chop 182 arrives at the position shown in Fig 11. The spikes (or fingers if the Fig 4 variant is used) engage the upper surface of the chop 182 while the blades slide therebelow into the position shown in Fig 12.

The arm is now operated so as to lift the chop 182 clear of the conveyors 174, 176 and to move the tooling so as now to be above the conveyor 176 to await the arrival of a tray 194 on conveyor 176 just below where the tooling will deposit chop 182 when located above conveyor 176, (or the movement of the tray 194 so that a first chop 196 already located therein is just ahead of where chop 182 will be deposited in the tray by the tooling 170).

The control system operates the tooling to open the blades to allow the chop 182 to drop into the tray above the trailing end of chop 196, so as to shingle the chops.

Moving the arm and tooling back to the position over conveyor 174 and repeating the procedure for the next chop 184 (and following chops in the line if required) and indexing tray 194 meanwhile by moving conveyor 176, allows a number of chops to be shingled into the tray 194.

The camera 186 (or another camera) inspects each chop to identify the fat edge region and thereby its orientation relative to the direction of conveyor movement, and further signals are generated by control system 188 to rotate the tooling (or the spiked plate 80 relative to the bridge 22, 24) so as to correctly orientate the chop 182 after it has been picked up from conveyor 174 and prior to it being deposited onto conveyor 176, so that each chop

deposited thereon will bear a correct orientation relative to any other chops it is to be associated therewith. Thus chops may be shingled (as shown in Fig 12) or may be arranged side by side in pairs, or threes, or fours in trays.

Other cameras may be provided to identify the orientation of the trays such as 194, to provide further reference signals for the control system to allow the chops to be rotated and positioned correctly relative to conveyor 176 and to trays carried thereon.

The chop cutting apparatus may shingle the meat as it is cut to form shingled groups of (say) four chops, as shown at 198 in Fig 13. These are shown in plan view on the conveyor 174 in Fig 13.

If the tooling is positioned around the group of chops 198 so that the two blades move inwards in the direction of the two arrows 200, 202 the shingled chops will not be disturbed significantly as the blades slide thereunder. Consequently the shingled group of chops 198 can be deposited as a single item into a waiting tray on the adjoining conveyor 176, instead of assembling a shingled group into a waiting tray one at a time, as previously described.

As before, shingled groups 198 can be rotated, each as a group, during transit from conveyor 174 to conveyor 176 so as to align with the appropriate dimension of each waiting tray on conveyor 176.

Stacks of bacon rashers (not shown) can be handles as single articles in the same way. Preferably the tooling is orientated so that the blades approach the rashers from opposite sides of the shorter dimension of the rashers forming the satck.

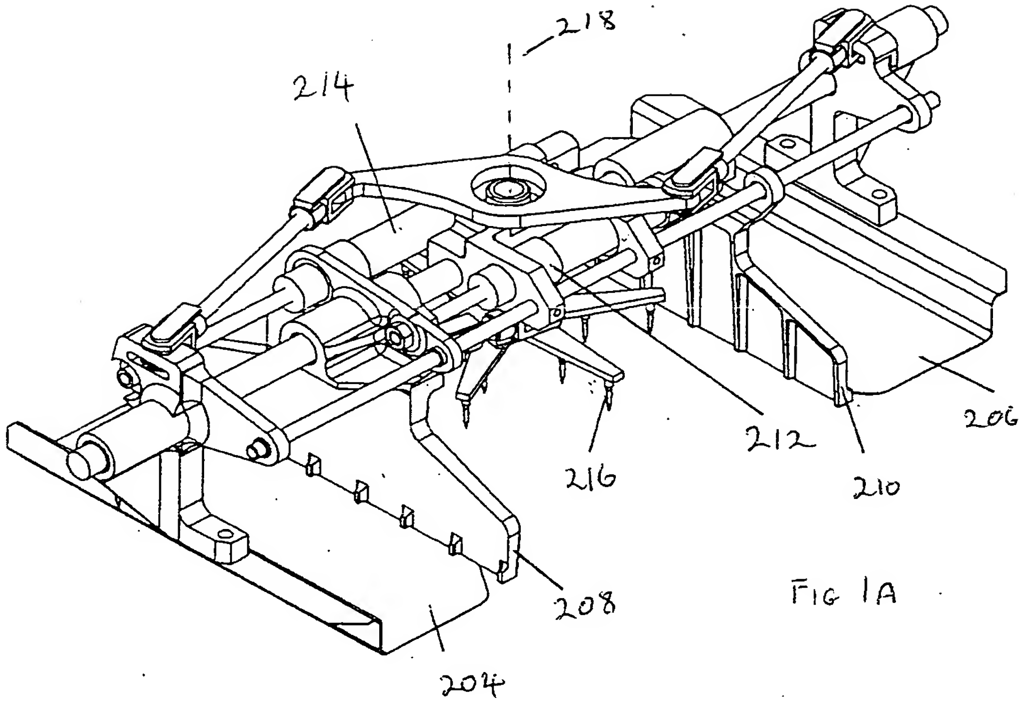

FIG 1A

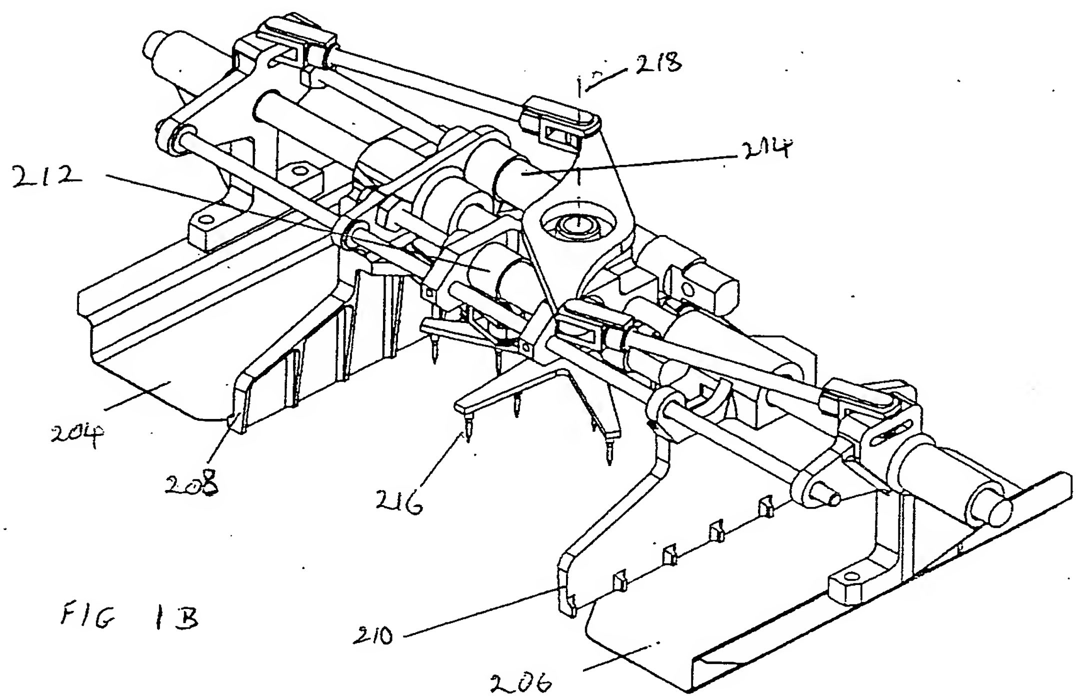

FIG 1B

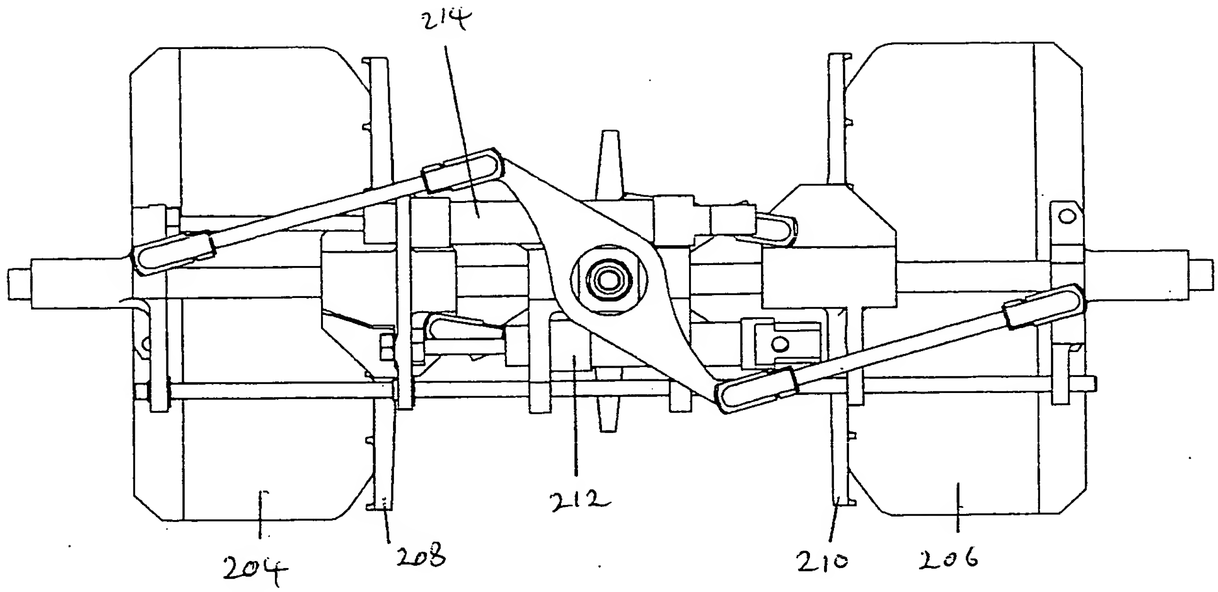

FIG 1C

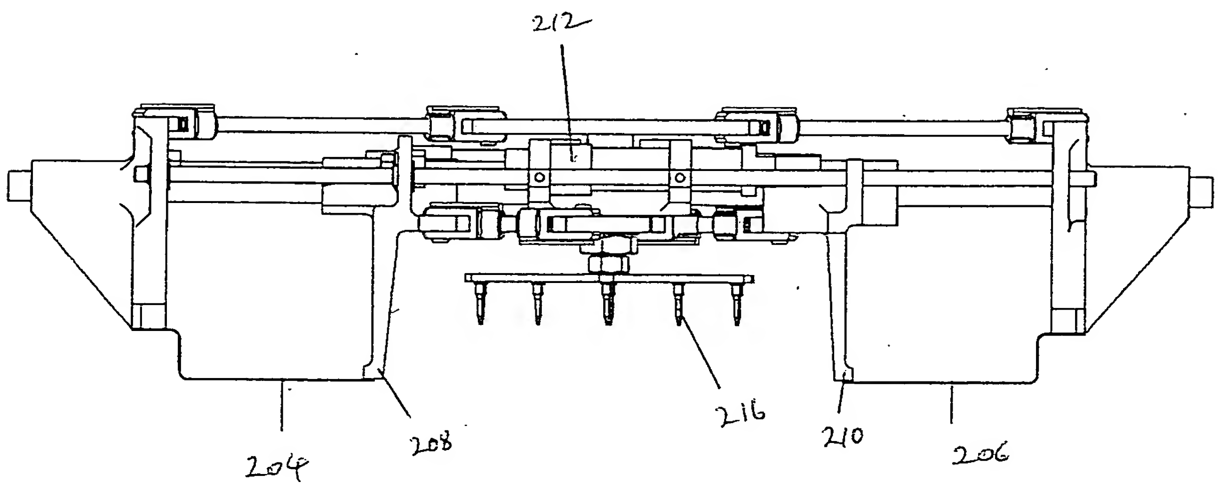

FIG 1D

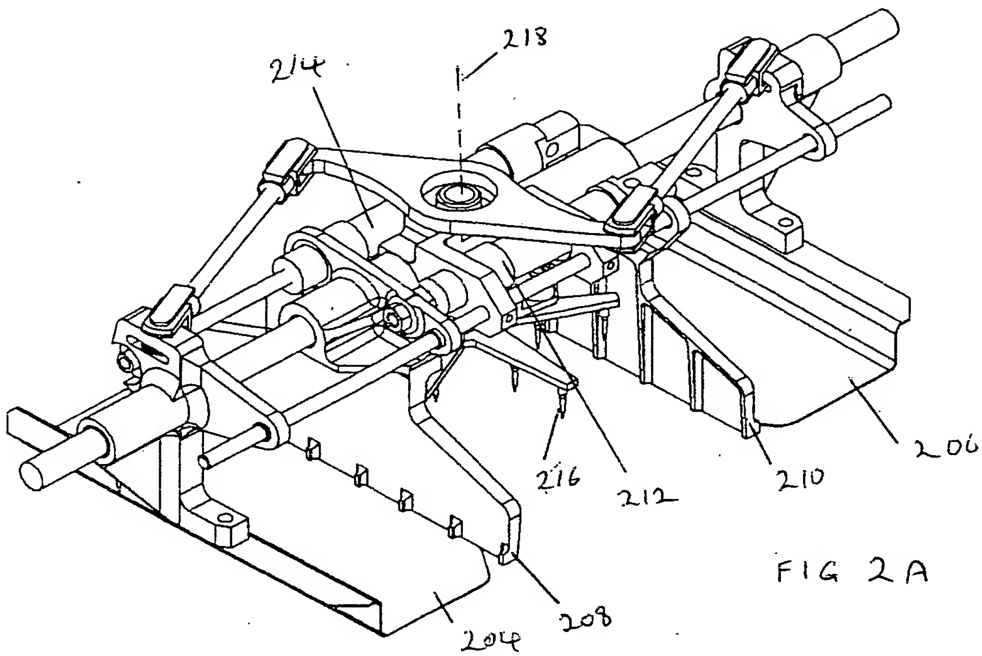

FIG 2A

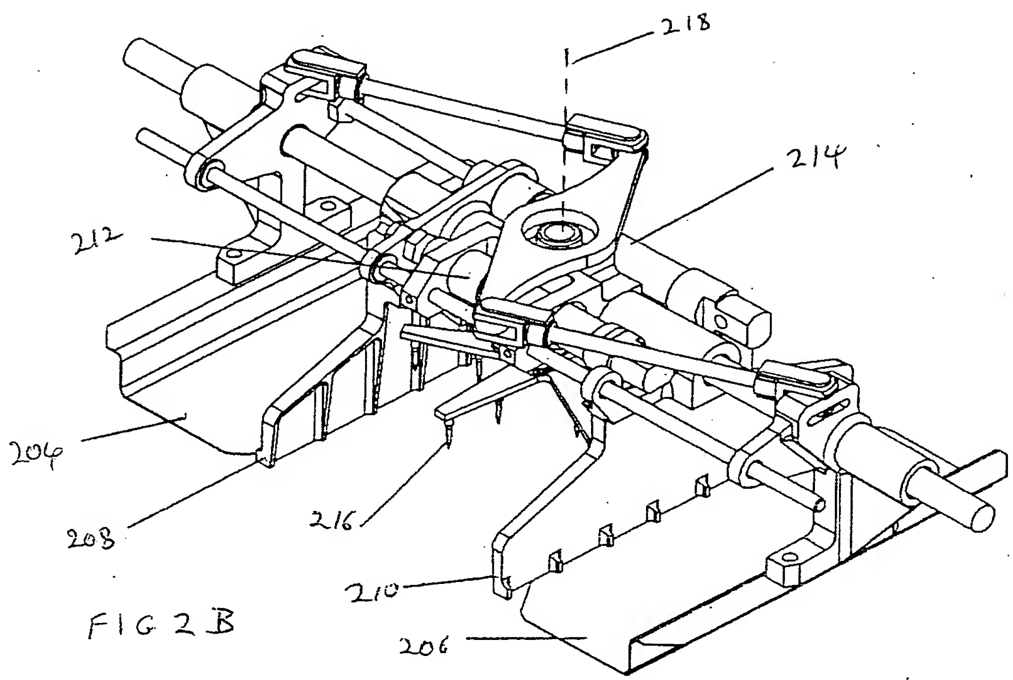

FIG 2B

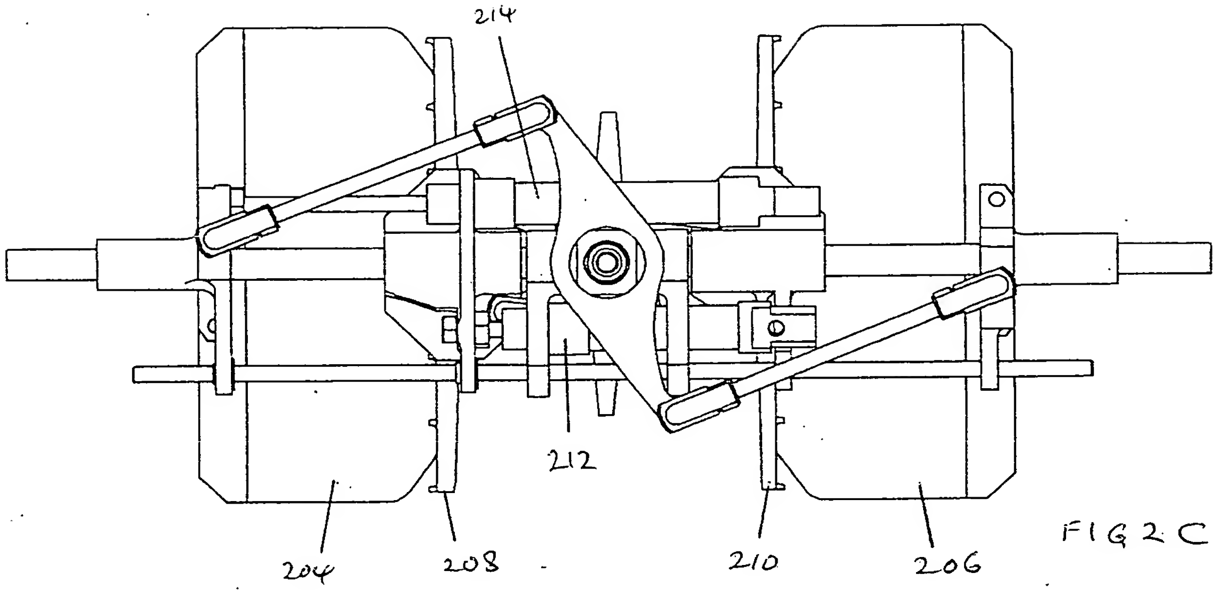

FIG 2C

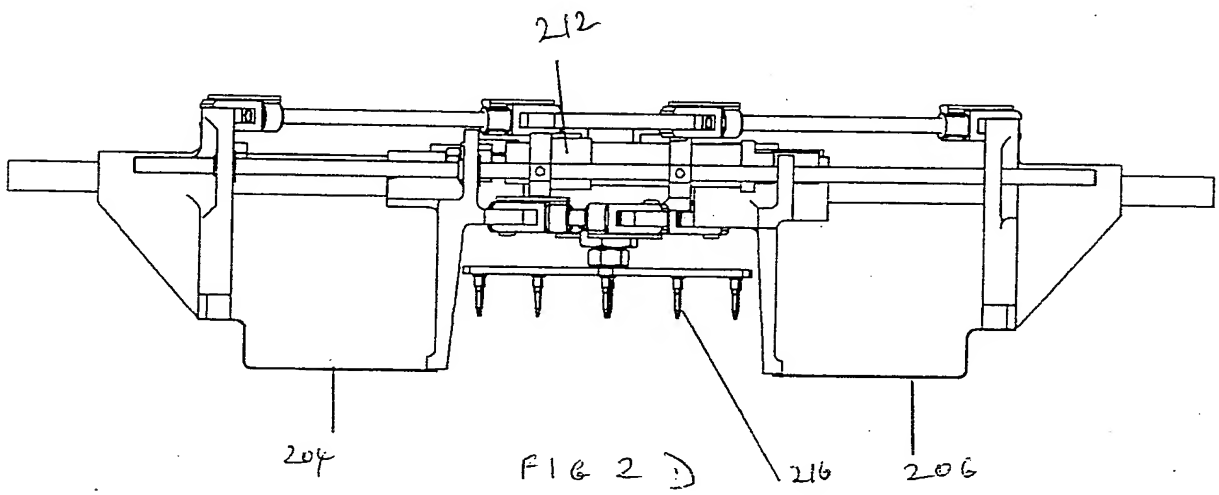

FIG 2D

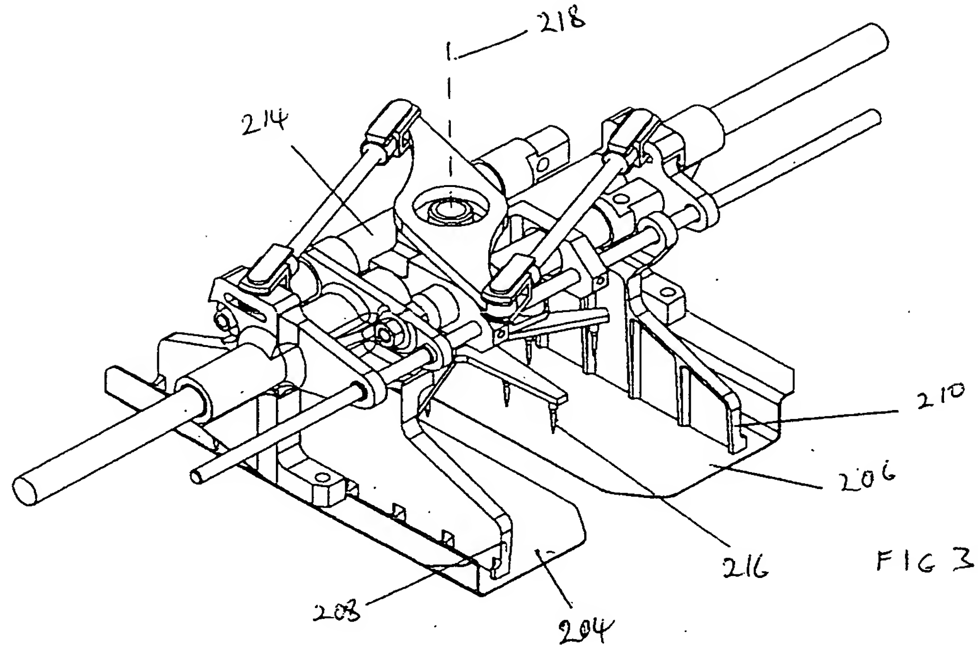

FIG 3A

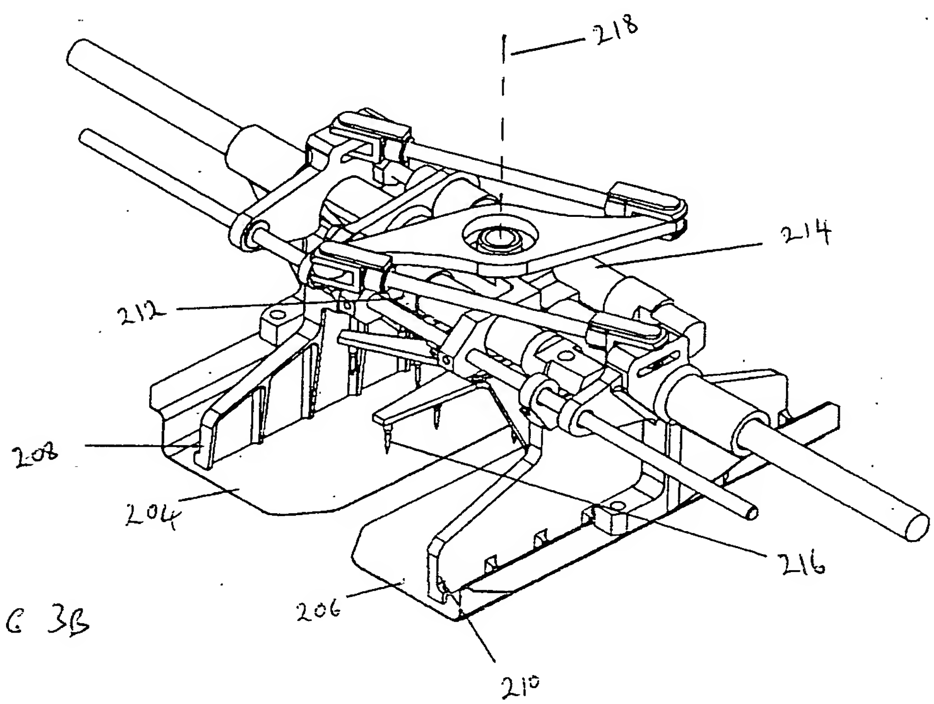

FIG 3B

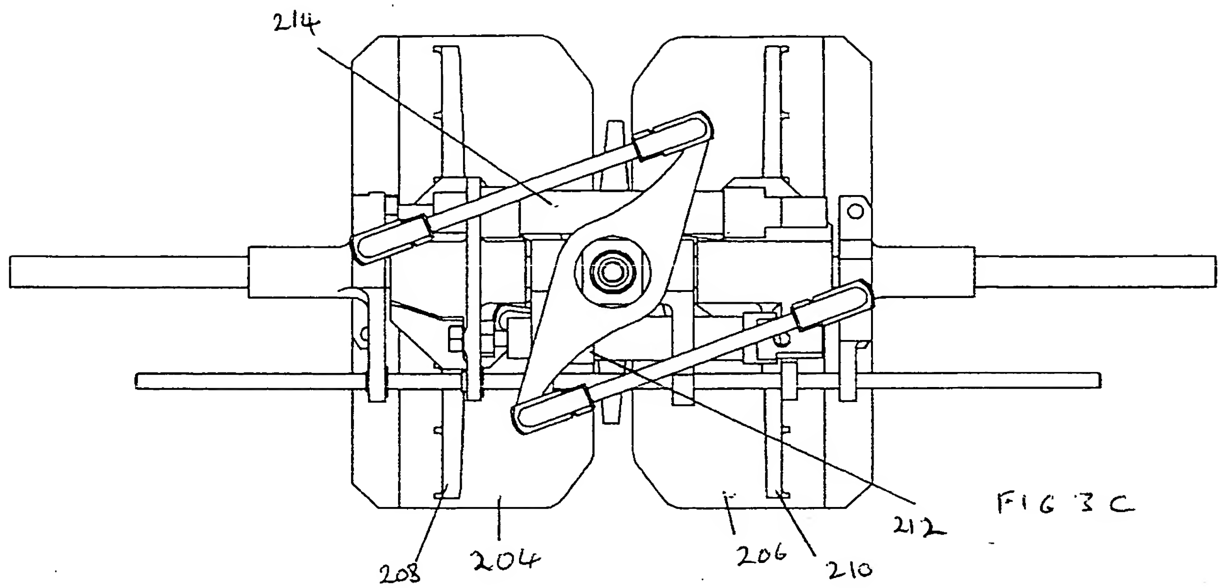

FIG 3C

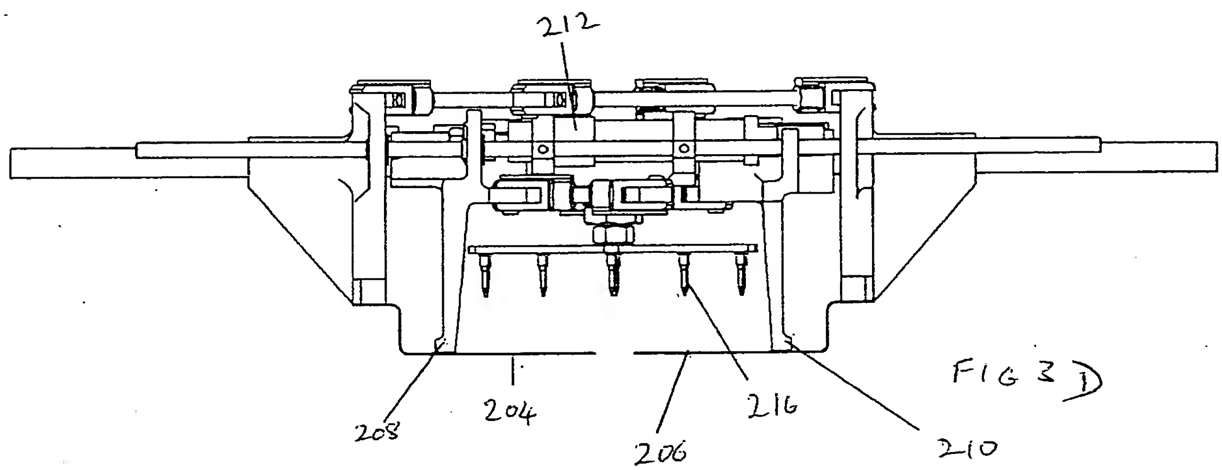

FIG 3D

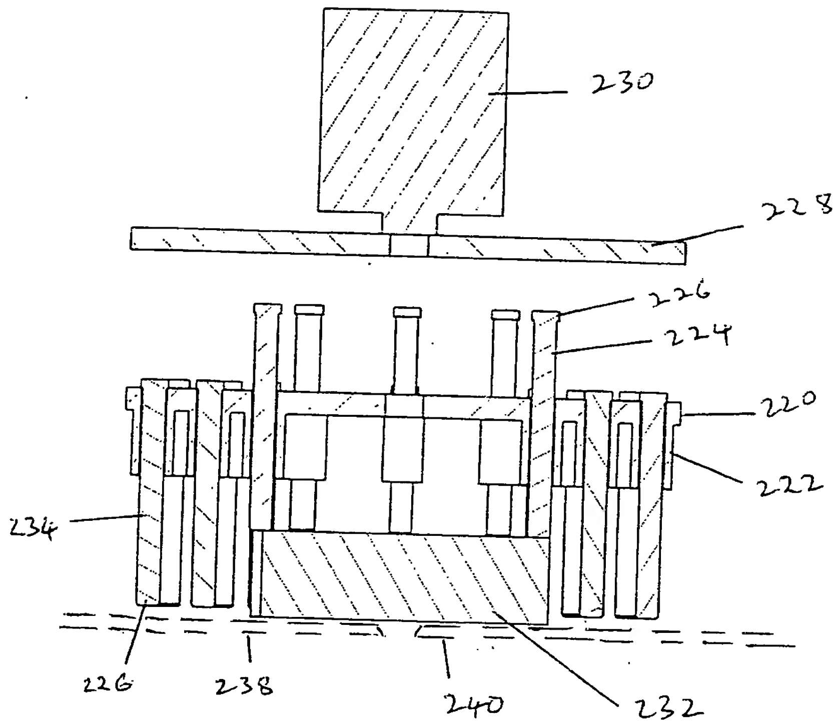
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FIG 4A

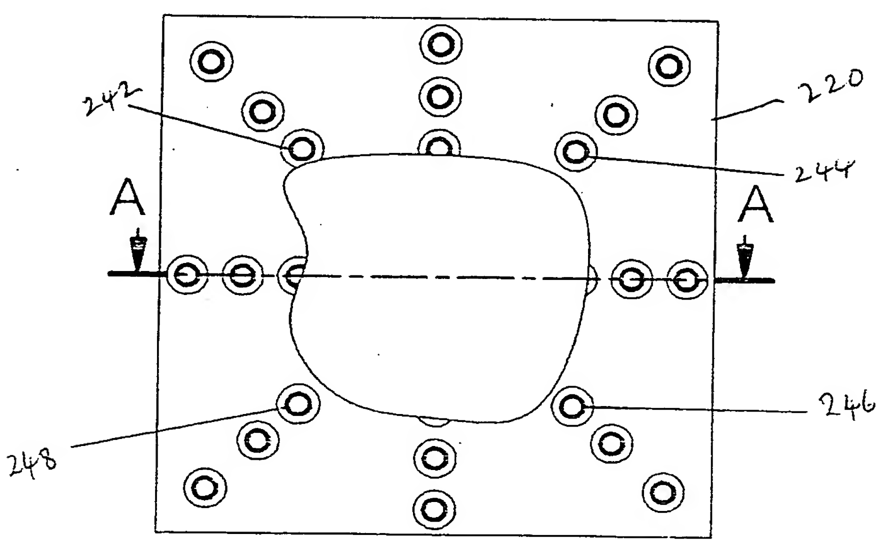
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FIG 4B